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Predictors of improvement in quality of life and pain relief in lumbar spinal stenosis relative to patient age: a study based on the Spine Tango registry

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Abstract

Background An open decompression is the most common treatment for lumbar spinal canal stenosis (LSS), even in the elderly. However, it is not clear whether the treatment outcome is age dependent. The main purpose of this study was to evaluate the improvement in quality of life (QoL) and pain relief, after open decompression for LSS in relation to patient age.

Methods The study was performed on the basis of Spine Tango registry data. The database query resulted in 4768 patients from 40 international Spine Tango centres. The patients were subdivided into three age groups: (1) 20–64, (2) 65–74, and (3) $\geq$75 years. In multivariate logistic regression models, predictors for improvement in QoL and achievement of the minimum clinically relevant change in pain of two points were analysed.

Results All groups benefited from significant improvement in QoL and back and leg pain relief. Age group had no significant influence on the outcomes. The preoperative status of each outcome was a predictor for its own postoperative outcome. Fewer previous surgeries, rigid or dynamic stabilization, and lower patient comorbidity also had a partially predictive influence for one or the other outcome.

Conclusions Our results confirm that all age groups significantly benefit from the open decompressive treatment of LSS. Age group had no significant influence on any outcome.

Keywords Spine Tango · Registry · Spinal stenosis · Decompression · Quality of life · Elderly

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Introduction

The most common age-related change to the spinal column is degenerative erosion which can lead to secondary narrowing of the spinal canal. Neurogenic intermittent claudication, a symptom of lumbar spinal stenosis (LSS), generally develops after the age of 50 [1]. LSS is one of the most widespread degenerative spinal diseases in the elderly. Symptoms can be pronounced enough to severely limit patient mobility. In addition to the typical neurogenic claudication, low back pain, numbness, weakness and tingling in the buttocks and/or thighs are commonly described symptoms, which can lead to psychosocial sequelae such as depression and isolation that impair quality of life [2–4].

Open decompression has become the most common surgical intervention for LSS in elderly patients [5]. If required, decompression may be combined with additional stabilization or fusion. The success of surgical LSS treatment is well documented [6–8].

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Although the incidence of surgical complications during surgical treatment for LSS is not age dependent, general complications do occur more frequently with increasing age [9]. However, an open decompression still remains a reasonable treatment option even in octogenarians [5, 10]. Patient age was considered in several studies as a potential predictor for clinical outcome after surgical treatment for LSS [11]. However, the vast majority of the studies included relatively small samples and some studies are relatively old [5, 11]. The current literature does not provide clear conclusions on the association of patient age with improvement in quality of life (QoL) and pain reduction after surgical treatment for LSS.

The purpose of this study was to assess the improvement in QoL and reduction in pain after open decompression for LSS in relation to patient age.

Materials and methods

The study was carried out using the Spine Tango data pool and written in accordance with Strengthening the Reporting of Observational studies in Epidemiology (STROBE) statement [12]. Spine Tango, the international spine registry of Eurospine, the Spine Society of Europe is hosted at the University of Bern's Institute for evaluative research in medicine [13]. Within the registry, patient and physician-based data are gathered in a prospective observational multi-centre manner.

The last three iterations of the Spine Tango surgery form (2005, 2006, and 2011) were used in the analysis. The physician-based forms collect demographic and diagnostic data, previous treatments and surgical details, etc. With regard to the following analysis, all three versions were compatible. The registry also collects outcome data, documented by the patients themselves mostly in the treating centre, but in about one-third of the patients, in the study independently from the treating centre at home. Treating centre collect the filled in forms and either send them to the back office in Bern for scanning or scan them locally if they have an optical marker reader. Among the available outcome instruments, the Core Outcome Measures Index (COMI) questionnaire is the most frequently used one in the registry. The COMI is a short, self-administered outcome instrument consisting of seven questions to evaluate the five dimensions pain, back-related function, symptom-specific well-being, general quality of life and disability (social and work) [14]. Two pain graphic rating scales (GRS 0–10 points) capture back and leg pain, and all other items use a 5-point adjectival scale. For the summary score, the average of the scores for all five dimensions (each transformed to 0–10) is calculated [14]. The question on quality of life ("Please reflect on the last week. How would you rate your quality of life?", taken from the WHOQoL questionnaire) has five response options: very good, good, moderate, bad, very and bad. At follow-up, an additional question on the patient's assessment of the overall treatment result [Global Treatment Outcome (GTO)] was asked ("Overall, how much did the operation in our hospital help your back problem?"), with five response options: helped a lot, helped, helped only little, did not help, made things worse. For subsequent analyses, the responses on the GTO scale were dichotomised as "good" (operation helped a lot or helped) and "poor" (helped only little, did not help, made things worse). A validated version of the COMI exists in English, German, Italian, French, Spanish, Norwegian, Hungarian, Portuguese, Chinese and Polish.

The study applied the following inclusion criteria: validated version of the COMI in the given country's language, lumbar degenerative spinal stenosis, patient age > 20 years, no additional spinal pathology (such as deformity, fracture, trauma, spondylolisthesis, inflammation, infection, tumour or failed surgery), decompression with or without rigid stabilization and/or fusion and/or dynamic stabilization, no anterior surgical measures, known ASA classification (American Society of Anaesthesiologists), preoperative and at least one postoperative COMI assessment available between 3 and 30 months (Table 1). If multiple surgeries were available for a patient, only the index surgery for LSS was considered. If multiple follow-up forms were available for a patient within the given follow-up period, the latest form was selected for analysis. Data from Finland, India, Moldova, Netherlands, Singapore, Slovenia, Taiwan, and Turkey were not considered due to the lack of a validated language version of the COMI (5.4 %, Table 1). The selection criteria resulted in 4768 patients from 37 departments from 35 Spine Tango centres from nine countries (Australia, Austria, Belgium, Germany, Italy, Poland, Switzerland, UK, and USA). The proportion of patients with an available COMI at baseline and a postoperative COMI at least 3 months after surgery was 46.0 % in the patient population (Table 1). The patients were subdivided into three socio-economically relevant age groups: (1) 20–64, (2) 65–74, and (3) $\geq$75 years. Demographic and clinical characteristics of these groups are summarized in Table 1.

Statistical analysis

Comparisons of preoperative patient characteristics between age groups were performed using Chi square test for nominal data and generalized linear modelling for ordinal data. Comparisons between baseline and follow-up pain levels and quality of life were performed using Wilcoxon signed-rank test and Chi square test, respectively.

Three binomial multivariate logistic regression models were built to analyse predictors of the following outcomes:

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Table 1 Selection algorithm and proportions of excluded data by selection parameter

Inclusion criteria	All primary forms (January 2004–March 2015), $N = 77{,}239$	
	Included	Excluded (%)
Hospitals with a valid COMI form in the national language	73,099 (94.6 %)	5.4
Index surgeries	65,131 (89.1 %)	10.9
Lumbar location (L1/L2–L5/S1)	47,411 (72.8 %)	27.2
Spinal stenosis	19,877 (41.9 %)	58.1
No additional pathology	13,462 (67.7 %)	32.3
Decompression	13,272 (98.6 %)	1.4
No anterior surgical measures	11,876 (89.5 %)	10.5
ASA classification known	10,375 (87.4 %)	12.6
Eligible for ≥3 months follow-up	10,204 (98.4 %)	1.6
Patient form (COMI) at baseline and at follow-up (3–30 months)	4768 (46.7 %)	53.3

(1) improvement in quality of life, (2) back pain relief, and (3) leg pain relief. The improvement in quality of life was dichotomized as "improvement of at least one category" (e.g. from moderate to good or from bad to moderate) or "no improvement or worsening". The back and leg pain relief was dichotomized into achievement vs. non-achievement of a minimum clinically relevant change (MCRC) in back and leg pain of two points on GRS, respectively [15].

As co-variates, age group, sex, ASA classification (1, 2, ≥3), extent of lesion (1, 2–3, >3 segments), number of previous surgeries (0, 1, >1), most severely affected segment (L1/L2, L2/3, L3/4, L4/5, L5/S1), rigid stabilization (yes/no), fusion (yes/no) and dynamic stabilization (yes/no), and the duration of COMI interval were included in the regression models. Additionally, QoL response, back and leg pain levels at baseline were considered in the respective models 1–3. Stepwise selection was used in all models.

The level of significance was set to 0.05 throughout the study. All statistical analyses were conducted using SAS 9.4 (SAS Institute Inc., Cary, NC, USA).

Results

The overall follow-up rate for the COMI assessment in this study population was 46.0 % (hospital-based mean rate 43.7 %; lower quartile 22.6 %, upper quartile 61.7 %). The follow-up rate in the age groups (1), (2), and (3) were 42.6, 49.2, and 50.0 %, respectively. Table 2 shows demographic and clinical characteristics of the age groups. The age groups had some significantly different characteristics with regards to ASA classification, extent of lesion, treated segments and the duration of COMI follow-up, though the largest group difference in mean COMI follow-up time was only about 1 month (Table 2). Patients in the oldest age group had greater comorbidity and a greater number of affected segments compared with the other two age groups. In the youngest age group, the L2/3 segment was less frequently affected and the L5/S1 segment more frequently affected than in the other two age groups.

Postoperative quality of life, back and leg pain relief

There was no significant difference between age groups in the proportions of patients that improved by at least one QoL category ($p = 0.86$) and achieved the MCRC in back pain ($p = 0.19$) and leg pain ($p = 0.94$) (Fig. 1).

In all age groups, a significant reduction in back and leg pain, and an improvement in the quality of life was documented ($p < 0.001$ for all outcomes in all groups).

The unadjusted comparisons of patient outcomes in the age groups showed pre- ($p = 0.003$) and postoperative back pain levels ($p < 0.001$) to be different between the age groups, with mean values ranging 5.5–5.9 and 3.3–3.8, respectively. Also, pre- ($p = 0.005$) and postoperative leg pain levels ($p = 0.001$) were different between the age groups, with mean values ranging 6.7–7.0 and 3.3–3.6, respectively. Neither back pain relief ($p = 0.17$), nor leg pain relief ($p = 0.58$) were significantly different between the age groups (Fig. 2).

The proportion of patients with good GTO was 72.5 % in the youngest, 75.4 % in the mid-age, and 71.6 % in the oldest age group ($p = 0.040$).

Quality of life

The multivariate logistic regression analysis revealed that worse preoperative quality of life, fewer previous surgeries, lower ASA status (less comorbidity), and the use of rigid stabilization were significant predictors increasing the likelihood of an improvement in quality of life postoperatively with the odds ratios listed in Table 3. The model required exclusion of 28 patients (0.6 %) who endorsed very good quality of life at baseline and were not able to improve postoperatively.

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Table 2 Patient characteristics in the age groups

Patient characteristics	(1) 20–64 (years)	(2) 65–74 (years)	(3) ≥75 (years)	Comparison (*p* value)	Total
N (%)	1752 (36.7)	1640 (34.4)	1376 (28.9)	na	4768 (100.0)
Mean age ± SD (years)	54.7 ± 8.5	70.2 ± 2.8	80.0 ± 3.6	na	67.4 ± 11.9
Age range (years)	22–64	65–74	75–98	na	22–98
Females (%)	46.8	45.9	48.0	0.51	46.8
ASA 1 (%)	35.3	12.5	4.5	<0.001	18.2
ASA 2 (%)	54.6	63.6	55.7		58.0
ASA > 2 (%)	10.1	24.9	39.8		23.8
Monosegmental (%)	54.9	41.9	32.4	<0.001	43.9
Bi- and trisegmental (%)	38.6	49.9	57.0		47.8
More than three segments (%)	6.5	8.2	10.6		8.3
No previous surgery (%)	80.5	78.8	82.7	0.09	80.6
One previous surgery (%)	14.6	16.4	12.9		14.7
Two or more previous surgeries (%)	4.9	4.8	4.4		4.7
L1/L2 (%)	0.8	1.3	1.1	<0.001	1.0
L2/L3 (%)	4.2	8.3	10.2		7.3
L3/L4 (%)	18.3	28.2	29.6		24.9
L4/L5 (%)	56.8	52.9	51.3		53.9
L5/S1 (%)	19.9	9.5	7.8		12.8
Fusion (%)	12.9	13.1	10.6	0.07	12.3
Rigid stabilization (%)	12.6	13.0	10.3	0.06	12.1
Dynamic stabilization (%)	8.2	9.5	7.1	0.06	8.4
Mean follow-up ± SD (months)	15.2 ± 8.7	16.0 ± 8.4	16.3 ± 8.4	<0.001	15.8 ± 8.5

na not analyzed, *SD* standard deviation

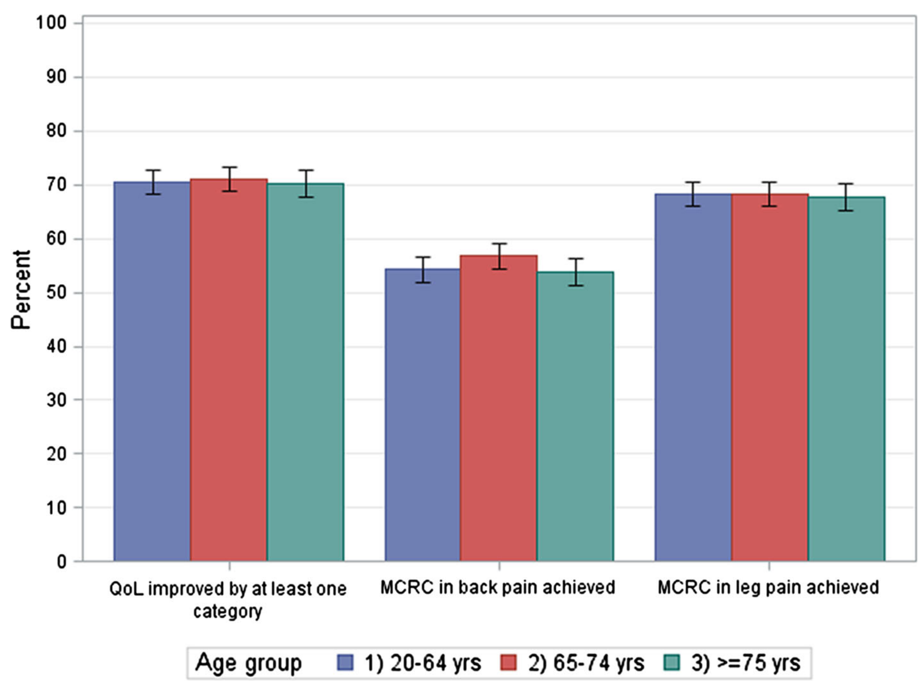

Fig. 1 Proportions of patients with an improved quality of life and achieving minimum clinically relevant changes in back and leg pain with 95 % confidence intervals in each of the age groups

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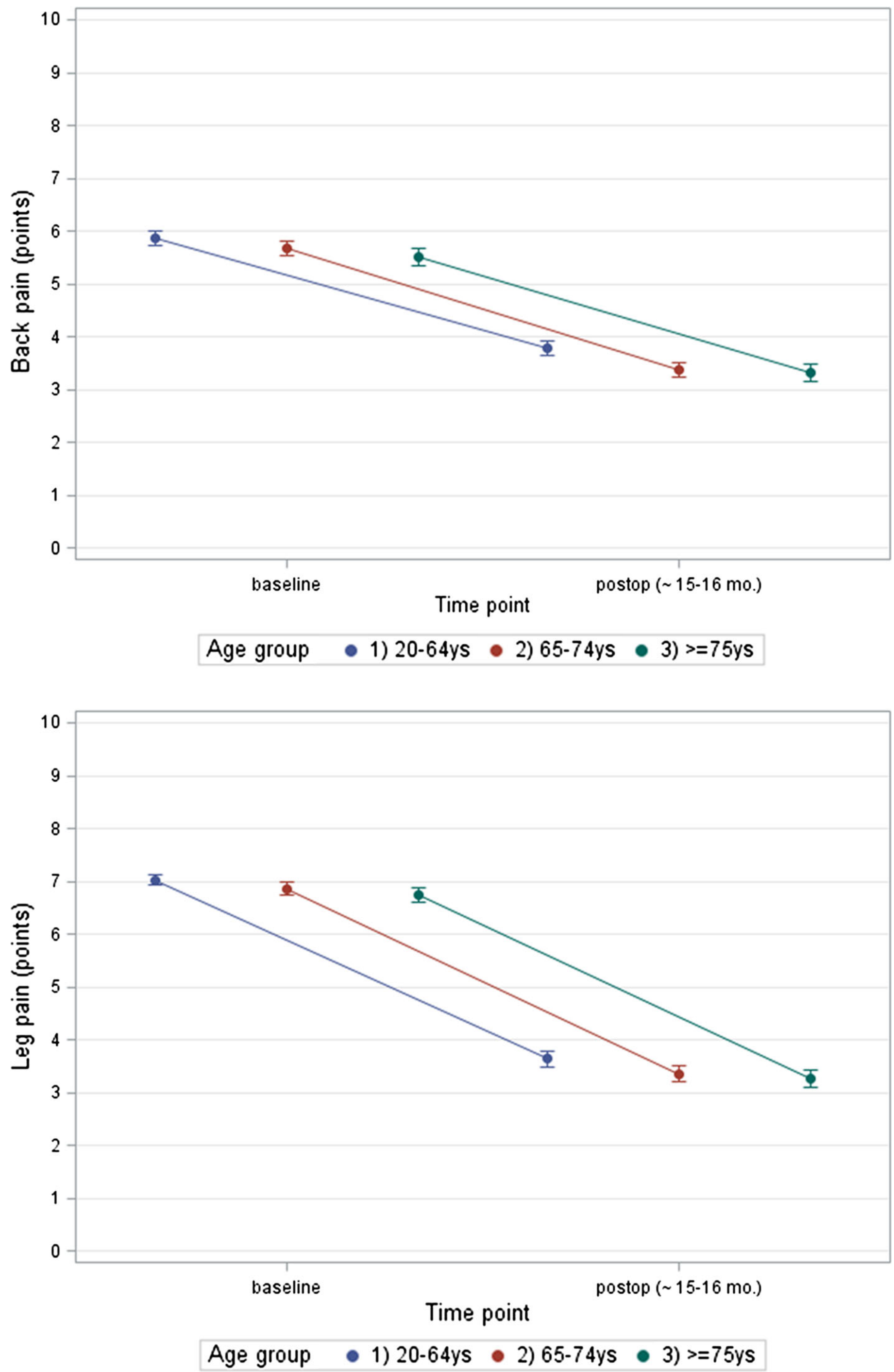

Fig. 2 Pre- to postoperative relief of back pain and leg pain with 95 % confidence intervals in the three age groups

Back pain

The multivariate regression analysis revealed that rigid and dynamic stabilization, and fewer previous surgeries were significant predictors increasing the likelihood of achieving a MCRC in back pain with the odds ratios listed in Table 4. Additionally, a significant interaction between back pain at baseline and age group was seen, implying that back pain at baseline has different effect in age groups.

Leg pain

The multivariate regression analysis showed that a higher preoperative leg pain, rigid and dynamic stabilization, and fewer previous surgeries were significant predictors increasing the likelihood of achieving a MCRC in leg pain with the odds ratios listed in Table 5.

Figure 3 demonstrates the average back and leg pain relief vs. continuous age stratified by the postoperative

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Table 3 Predictors of improvement in quality of life postoperatively of at least one category

Co-variate	*p* value	Effect	OR	95 % CI
Rigid stabilization	0.017	Yes vs. no	1.3	1.05–1.60
ASA classification	0.002	2 vs. 1	0.86	0.72–1.03
		>2 vs. 1	0.69	0.56–0.85
Number of previous surgeries	<0.001	1 vs. 0	0.73	0.61–0.87
		>1 vs. 0	0.55	0.41–0.74
Preoperative QoL	<0.001	Per worse response option	2.6	2.38–2.84

Probability modelled for postoperative quality of life improvement of at least one category

OR odds ratio, *95 % CI* 95 % Wald confidence intervals

Table 4 Predictors of the achievement of a minimum clinically relevant back pain relief of two points

Co-variate	*p* value	Effect	OR	95 % CI
Rigid stabilization	<0.001	Yes vs. no	1.80	1.47–2.22
Dynamic stabilization	0.008	Yes vs. no	1.38	1.09–1.75
Number of previous surgeries	0.002	1 vs. 0	0.75	0.62–0.90
		>1 vs. 0	0.72	0.53–0.98
Preoperative back pain* age group	0.037	Per point in age group = (1) 20–64 years	1.38	1.33–1.44
		Per point in age group = (2) 65–74 years	1.44	1.38–1.50
		Per point in age group = (3) ≥75 years	1.50	1.43–1.57

Probability modelled for the achievement of the two points

OR odds ratio, *95 % CI* 95 % Wald confidence intervals, * interaction

Table 5 Predictors of the achievement of a minimum clinically relevant leg pain relief of 2 points

Co-variate	*p* value	Effect	OR	95 % CI
Rigid stabilization	0.028	Yes vs. no	1.26	1.03–1.54
Dynamic stabilization	0.002	Yes vs. no	1.49	1.16–1.92
Number of previous surgeries	<0.001	1 vs. 0	0.72	0.60–0.86
		>1 vs. 0	0.58	0.43–0.78
Preoperative leg pain	<0.001	Per point	1.38	1.34–1.42

Probability modelled for the achievement of the two points

OR odds ratio, *95 % CI* 95 % Wald confidence intervals

QoL group. It can be observed that the average back pain relief in patients with an improved QoL was two points or more greater than that of patients without any improvement in QoL. Regarding the average leg pain relief, the difference between the groups was even higher, at around three points. Importantly, there were no relevant trends across patient age in any of the QoL groups, for either back pain or leg pain relief.

Discussion

Patient age and treatment outcome

All age groups benefited significantly from surgery in terms of pain relief and improved quality of life. There is general consensus that the surgical treatment of LSS in all age groups, including old (>65 years) and elderly (>80 years) patients, significantly improves walking distance [10, 16–19], reduces pain [10, 18–23], and decreases consumption of pain killers [18, 19]. Additionally, significant reductions in the need for physiotherapy or other medical treatments [18], as well as significant improvements in Oswestry Disability Index scores [18, 23] and SF-36 scores [22, 23] have been reported.

Several studies addressed the influence of age on the clinical outcome. Aalto et al. performed a systematic review of randomized controlled trials, controlled trials, and prospective cohort studies examining preoperative predictors for clinical outcomes in LSS patients [11]. Eight out of 21 publications were rated as high and 13 as low quality studies. The authors found that age did not

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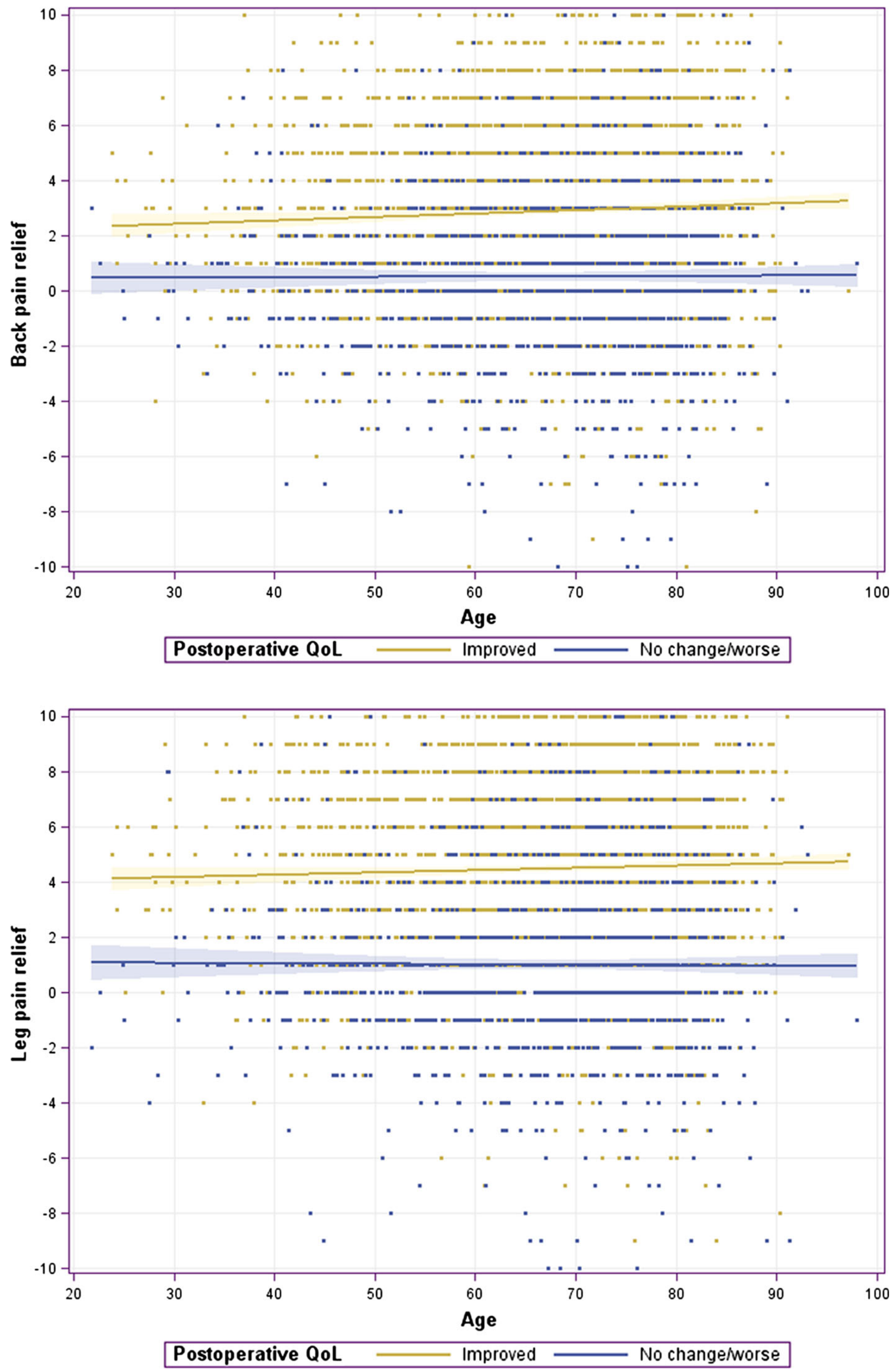

Fig. 3 Average back and leg pain relief vs. continuous age stratified by the QoL group (improved QoL vs. no change/worse QoL after surgery) with 95 % confidence intervals

influence outcome, and an association between age and postoperative walking ability was observed in only one high quality study [11]. Similarly, other research groups did not identify correlations between age and outcome after surgical treatment of LSS [10, 24]. Recently, Ulrich et al. demonstrated that octogenarians can benefit from a meaningful improvement after lumbar decompression in LSS [5]. However, the mentioned studies had relatively low sample sizes of less than 100 cases. The two largest studies were published in 1998 and included 170 and 257 patients [25, 26].

In the present study, postoperative improvement in QoL did not differ significantly between the age groups in either the adjusted or non-adjusted analyses. The age groups were also similar regarding back and leg pain relief in the adjusted and non-adjusted analyses, although preoperatively, the groups presented with significantly different back pain levels. Similarly, a single-centre prospective study on 100 patients with one-year follow-up by Thornes et al. reported no significant difference in outcome scores (Swiss Spinal Stenosis Questionnaire and SF-36) in patients older and younger than 65 years. In contrast, older patients were four times more likely to be dissatisfied with the outcome after surgery than the younger ones [27]. Also, in our cohort, a significantly lower proportion of patients in the older group rated their outcome as good in the bivariate comparison among all age groups.

Predictors

In the current study, the levels of preoperative back pain, leg pain and quality of life had a significant influence on the subsequent postoperative values for the respective parameters. The worse the preoperative status the greater was the likelihood of postoperative improvement. This is a known phenomenon for various outcomes in LSS and in other spinal disorders [24, 28].

Previous surgery had a negative influence on all three outcomes. This may be explained by the fact that patients requiring further lumbar surgery suffer from LSS symptoms potentially for a longer period of time. They are dissatisfied, and need yet another intervention. Szpalski et al. found that back pain sufferers consider themselves to be in generally good health with good QoL, but also noted that patients who had undergone multiple surgeries had a lower opinion of their general health status versus those who had not undergone surgery [29]. Moreover, Saban et al. reported that patients with higher degrees of optimism perceived significantly better QoL and increased fulfilment of expectations [30].

ASA status partially influenced the improvement in QoL. Although the effective difference in the proportion of improved patients between ASA 1 and >2 subgroups was only about 2 %, the adjusted analysis suggested that low versus severe preoperative comorbidity leads to greater benefits after LSS surgery regarding quality of life.

Patients treated with posterior dynamic stabilization had higher likelihoods of achieving a minimum clinically relevant pain relief for both back and leg pain. Dynamic stabilization aims to retain range of motion of the treated segment without increasing stresses on the adjacent level. This should theoretically promote the recovery of treated segments and prevent degeneration of the adjacent ones. The reports on posterior dynamic stabilization systems are controversial [31–36]. Long-term level I evidence will not be available for many years, so the rationale for utilizing dynamic stabilization will continue to be based on the belief in a theoretical benefit from controlling instead of completely eliminating motion.

The use of rigid stabilization was associated with an increased likelihood of achieving an improvement in quality of life and a clinically relevant improvement in back and leg pain, while fusion itself was not. Being the most invasive surgical approach, instrumented fusion is also the more consequent therapy for segmental instability existing preoperatively or resulting from extensive decompression. Different types of fusion (anterior, posterior, 360°) may also lead to different degrees of improvement, but the more complex arthrodeses also have the highest reoperation and complication rates [15, 37]. Consequently, many spine surgeons prefer not to use instrumentation in the absence of gross segmental instability. The study from the Swespine register by Forst et al. did not find additional fusion to improve clinical outcome after decompressive surgery for LSS [38]. Also, an RCT on 229 patients from the same authors did not show any benefits of an additional fusion in comparison with decompression alone [39]. The comparative effectiveness of different surgical approaches was not the focus of this study and the methodology was not appropriate to answer such a question. Therefore, conclusions regarding the potential benefit of one treatment over the other should not be drawn from the current analysis. Further detailed studies comparing main types of treatment for lumbar spinal stenosis in such large cohorts are required.

Additional predictors for poorer subjective outcomes mentioned in the literature include depression, cardiovascular comorbidity, the presence of disorders influencing walking ability, and scoliosis. In turn, better walking ability and self-rated health, higher income, lower overall comorbidity, and pronounced central stenosis predict better subjective outcomes [11]. However, most of these variables were not measured in the present study.

Limitations and strengths of the study

The major strength of the analysis is the large sample size and routine clinical settings from which the data were drawn. This allows for an accurate detection of significant predictors relevant to the typical type of stenosis surgery performed in daily practice. Particularly in such large cohorts, the clinical relevance and meaningful association of a predictor with an outcome needs to be reported in addition to any statistical significance. At least for the main outcomes and predictors, we consider the observed effects to be clinically relevant. The study population had an overall follow-up rate of 46.7 %. Despite multinational registry setting and a large number of participating hospitals, this rate should still be considered as a limitation of the study. Furthermore, data from nine countries were included in the study. Cultural and healthcare system differences may have potentially influenced the results of the study. Detailed analyses of countries and individual centres are required to uncover their effects. Also, about two-third of the patients filled in the self-administered COMI at the treating centre during follow-up, as mentioned above. An influence of the physician on the COMI-responses cannot be completely ruled out in these patients, although it would not be expected to have different effects in the different age groups.

The main criticism of medical registries is their unmonitored character, which may lead to a biased capture of the successful cases only. However, there is little reason to believe that a potential selection bias would affect the studied age groups in a differential way, even though the follow-up rate in the youngest age group was about 7 % lower than in the other two age groups. The youngest group had a working age and therefore these patients were potentially less compliant to follow-ups. Patient-rated outcomes were also used in the study, which are less prone to bias. The rates for dural lesions, as the surrogate for a credible documentation, appear to be higher in the Spine Tango than in the Swedish spine registry [15]. Furthermore, a Spine Tango code of conduct was recently introduced to foster honest, transparent, and monitored documentation.

We dichotomized the five response categories for quality of life into improvement of one or more categories vs. no change or worsening. The model required exclusion of 28 patients (0.6 %) who endorsed very good quality of life at baseline and were not able to improve postoperatively. Alternatively, one could assess the pre-to-postop change more exactly considering the number of improved categories. However, a much larger ceiling effect can be expected in this analysis.

Conclusions

Our results confirmed that all age groups showed a significant improvement in pain and quality of life after surgical treatment of lumbar spinal stenosis. The level of preoperative back pain, leg pain and quality of life influenced the respective postoperative values. Rigid stabilization and fewer previous surgeries were independent predictors of all three outcomes. Additionally, the comorbidity status partially influenced the improvement in quality of life, and dynamic stabilization influenced back and leg pain relief. As this study was not designed to answer the question of comparative superiority of one treatment over the other, the effects of rigid and dynamic stabilizations as independent predictors for a better surgical outcome should be interpreted with caution. Age group had no influence on the improvement in quality of life or relief of back and leg pain after the surgical treatment of lumbar spinal stenosis.

Key points

- All age groups showed significant improvements in quality of life and pain after LSS surgery.
- Age group did not influence the extent of improvement in QoL or back and leg pain relief.
- Preoperative levels of back pain, leg pain and quality of life influence their respective postoperative values.
- Fewer previous surgeries increase the likelihood of improvement in pain and QoL.

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Compliance with ethical standards

Conflict of interest None.

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